Electronic supplementary information

3D-Printed Cu_2O Photoelectrodes for Photoelectrochemical Water Splitting

Jinhyuck Ahn, [#,a,b] *Sanghyeon Lee,* [#,c] *Jung Hyun Kim,* [a,b] *Muhammad Wajahat,* [a,b] *Ho Hyung Sim,* [a,b] *Jongcheon Bae,* [a,d] *Jaeyeon Pyo,* [a] *Muhammad Jahandar ,* [e] *Dong Chan Lim,* [e] *and Seung Kwon Seol*,* [a,b]

[a]Nano Hybrid Technology Research Center, Korea Electrotechnology Research Institute (KERI), Changwon-si, Gyeongsangnam-do, 51543, Republic of Korea.

[b]Electrical Functionality Material Engineering, University of Science and Technology (UST), Changwon-si, Gyeongsangnam-do, 51543, Republic of Korea.

[c]Department of Mechanical Engineering, The University of Hong Kong, Pokfulam Road, Hong Kong, China.

[d]School of Materials Science and Engineering, Pusan National University, Busan, Republic of Korea.

[e]Surface Technology Division, Korea Institute of Materials Science (KIMS), Changwon-si, Gyeongsangnam-do, 51508, Republic of Korea.

KEYWORDS: photoelectrochemical water splitting, Cu_2O, 3D photoelectrode, p-n homojunction, 3D printing, electrodeposition

***Author to whom correspondence should be addressed:**

Seung Kwon Seol**,** Phone: +82-55-280-1462**;** E-mail: skseol@keri.re.kr

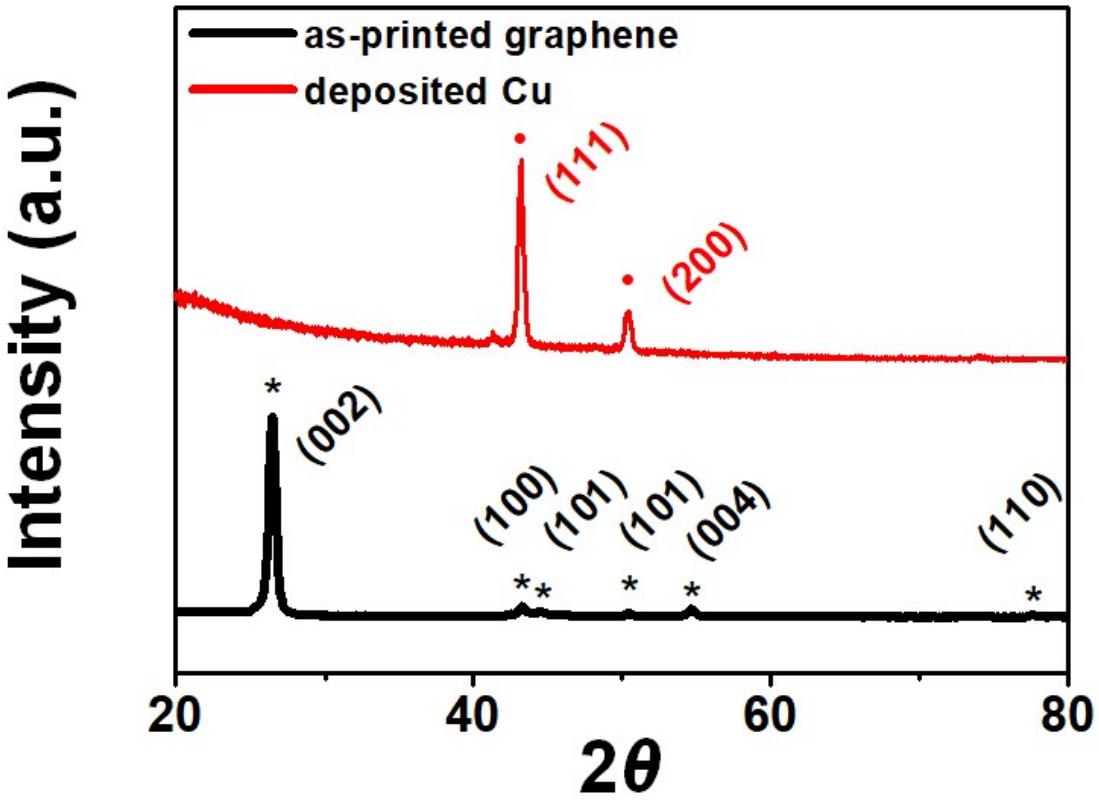

Fig. S1. XRD patterns of the as-printed graphene pyramids and deposited Cu on the 3D-printed pyramids.

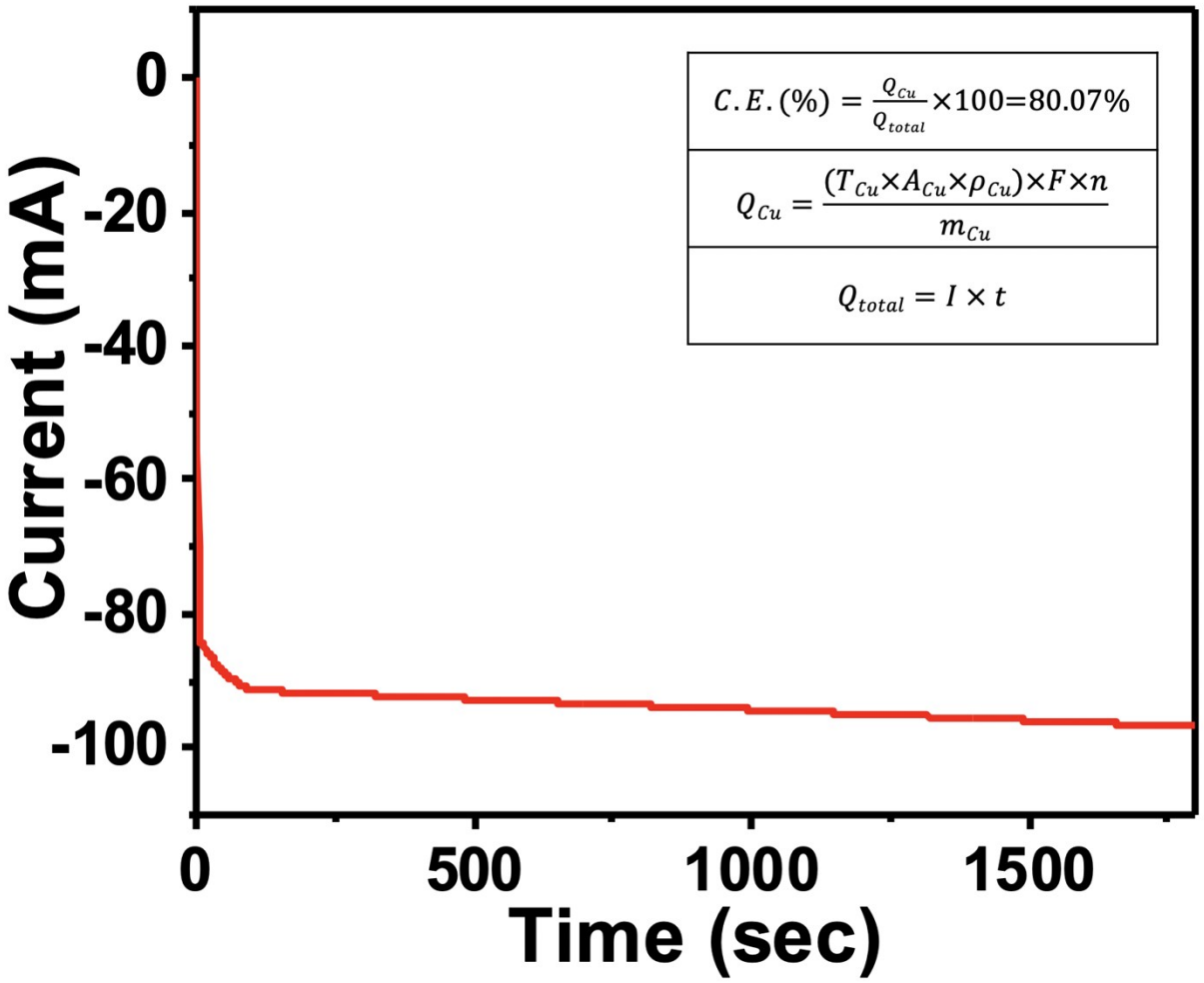

Fig. S2. Chronoamperometry showing Cu electrodeposition on the printed 400 graphene pyramids (L_b = 450 μm and h_p = 390 μm) at −0.4V (vs. Ag/AgCl). Inset, the table showing the current efficiency equation of Cu electrodeposition. (*C.E.*, Q_{total}, Q_{Cu}, T_{Cu}, A_{Cu}, ρ_{Cu}, F, n, m_{Cu}, I and t are current efficiency, total electrical charge, electrical charge of Cu deposition, thickness of Cu deposition, area of Cu deposition, density of Cu deposition, Faraday constant, equivalent of Cu, atomic weight of Cu, total current, and deposition time, respectively)

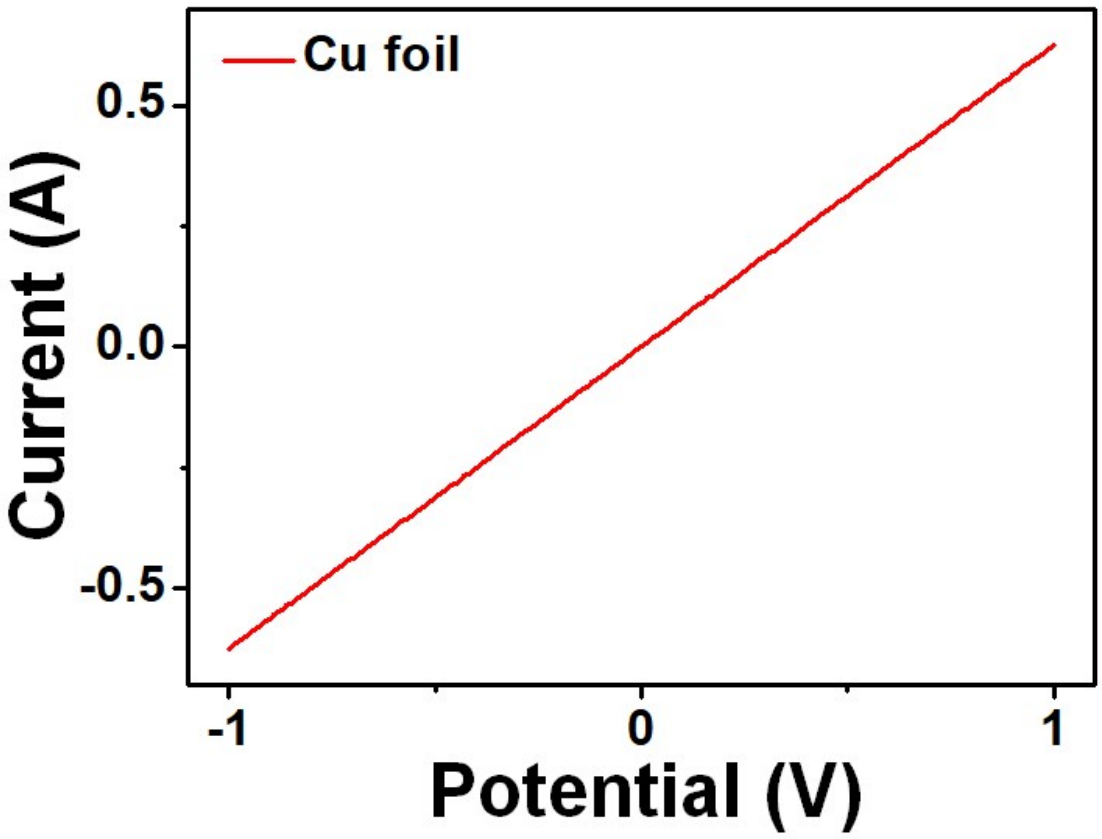

Fig. S3. *I–V* characteristics of typical Cu foil (thickness of ~20 μm). The resistance (1.58 Ω) of the electrodeposited Cu layer on the 3D-printed pyramids is similar to that of typical Cu foil (1.55 Ω).

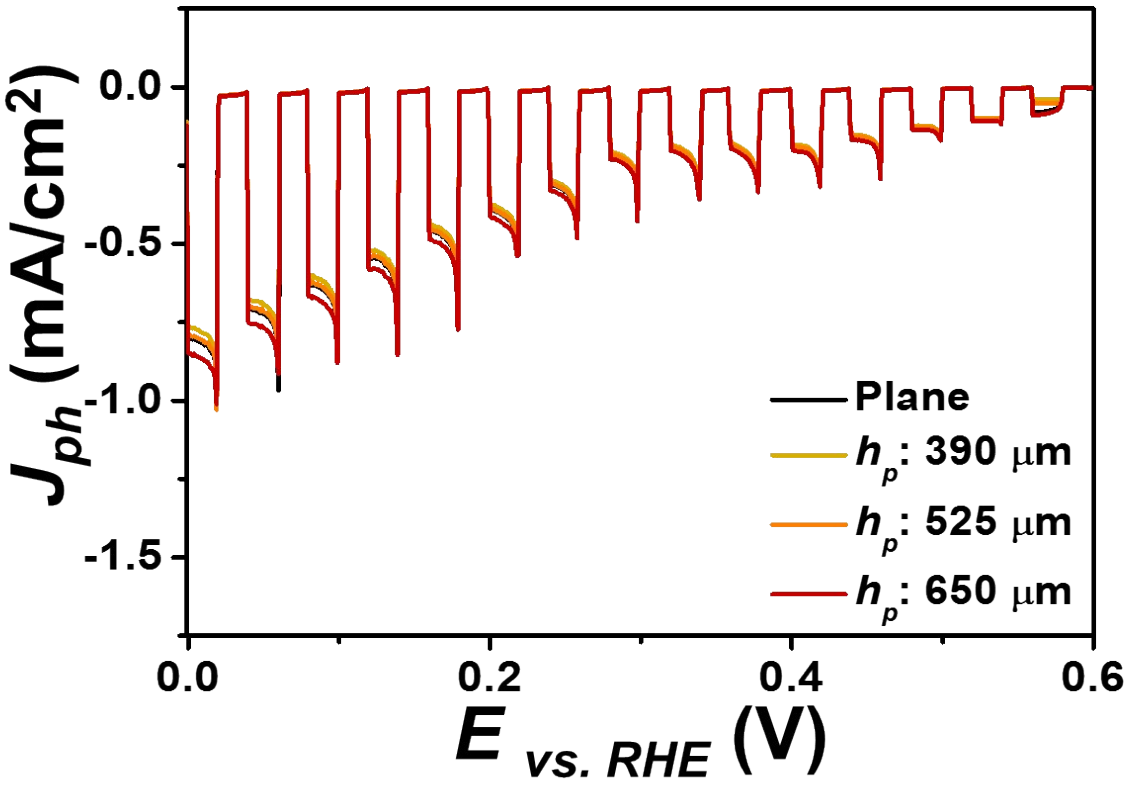

Fig. S4. Photocurrent density (J_{ph}) of the p-n homojunction Cu_2O electrodes with planar and 3D pyramid shapes.

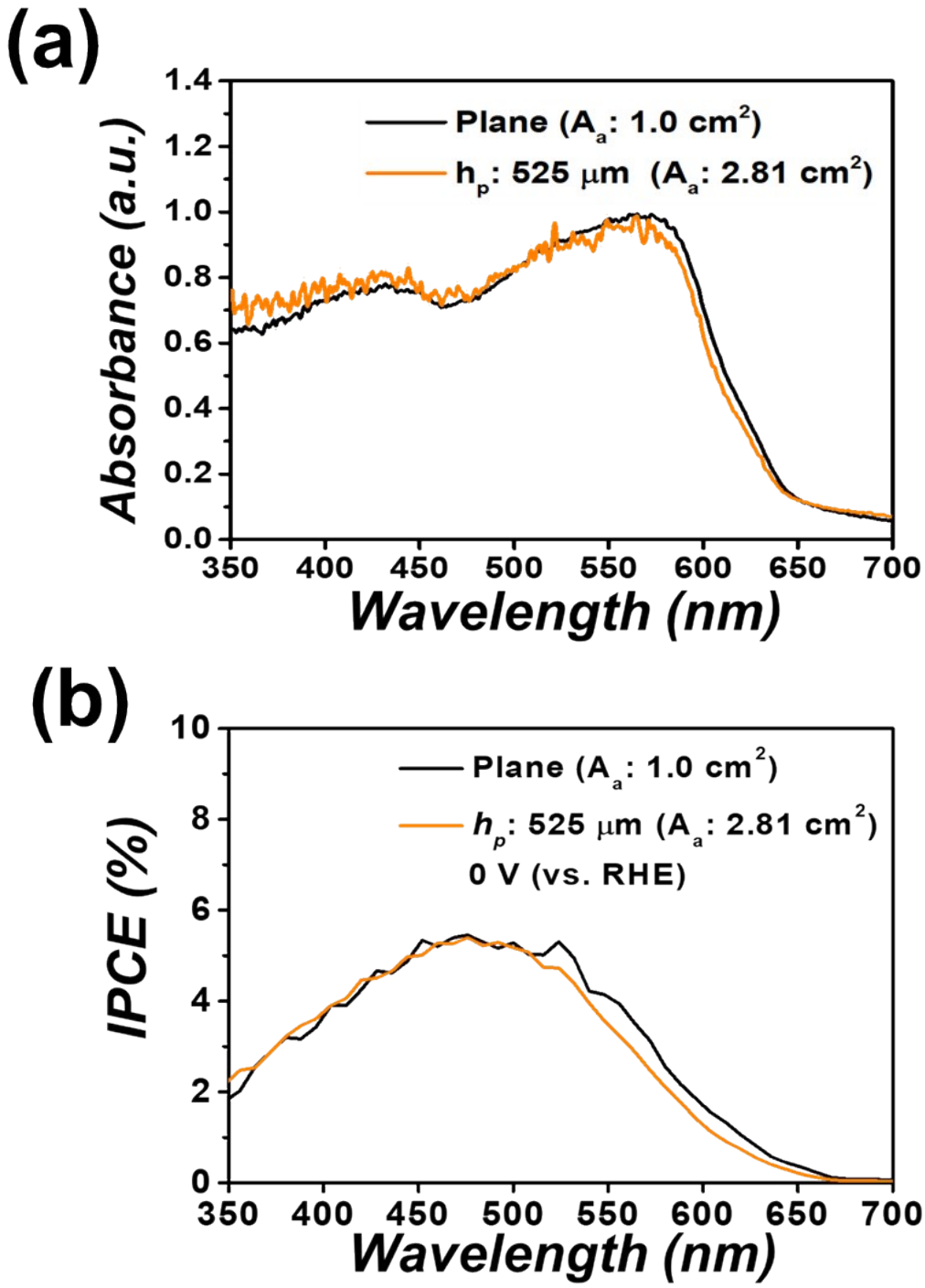

Fig. S5. (a) UV-vis absorption spectra and (b) IPCE curves of the p-n homojunction Cu_2O electrodes with planar and 3D pyramid shapes.

Video 1: 3D printing of the graphene pyramids (*ID* = 100 μm) (AVI)

Video 2: The effect of ethyl cellulose (EC) as a rheological modifier for continuous ink dispensing and as a binder for maintaining the shape of printed structures (AVI)